m/035/009

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March 7, 2000

Mr. Don A. Ostler, Director
Utah Department of Environmental Quality
Division of Water Quality
P.O. Box 144870
Salt Lake City, Utah 84114-4870

Subject: <u>Transmittal of the Revised Updated Waste Rock Management Plan for the Barneys Canyon Mine, Permit Number UGW350001</u>

Dear Mr. Ostler:

Attached is the final draft of the Barneys Canyon Waste Rock Management Plan. This version incorporates all of the changes requested in your approval letter dated 2/25/00. The following issues regarding the sulfide repository cap design have been addressed:

- The thickness of the fine-grained growth media has been increased from 2 to 3 feet;
- The oxide waste rock cap will be a minimum of ten feet thick;
- The seed and seedling list that was approved by the Division of Oil, Gas and Mining has been included in the plan;
- Several of the papers reviewed by the Division of Water Quality that support the revised cap design have been included in the reference list.

A copy of this final version of the plan has also been transmitted to Wayne Hedberg of the Division of Oil, Gas and Mining. If you have any questions or comments about this plan please call me at 569-7110 or Rich Borden at 569-6208.

Sincerely,

Ray Gottling

Ray Gottling
Operations Manager

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DIVISION OF
OIL, GAS AND MINING

Attachment

cc: Wayne Hedberg, Division of Oil, Gas and Mining m/035/009

BARNEYS CANYON MINE

WASTE ROCK MANAGEMENT PLAN

Groundwater Discharge Permit
Number UGW350001

Kennecott Barneys Canyon Mining Company
Revised March, 2000

BARNEYS CANYON MINE
WASTE ROCK MANAGEMENT PLAN
Revised March, 2000

1.0 INTRODUCTION

This Waste Rock Management Plan is required by Barneys Canyon Mine Groundwater Discharge Permit Number UGW350001. The most recent version of this permit was issued on July 20, 1999 and requires that a revised Waste Rock Management plan be submitted within 90 days. This plan supersedes the original Waste Rock Management Plan for the Barneys Canyon Mine that was issued on October 12, 1993 and revised on September 2, 1994. This latest version of the plan also supersedes the earlier version that was submitted to the Division of Water Quality on October 19, 1999.

Only the Melco pit at the Barneys Canyon Mine is currently active. The four other open pits and their associated waste rock dumps are no longer in use, but have not yet been fully reclaimed. This plan briefly describes the geochemistry of all existing waste rock dumps and open pits, and assesses the risk of Acid Rock Drainage (ARD) formation and sulfate release. This plan also describes current rock and water management procedures and future reclamation activities.

2.0 WASTE ROCK ARD POTENTIAL

In general, previous studies have concluded that well blended waste rock dumps at the Barneys Canyon Mine have little potential to generate Acid Rock Drainage (ARD) and in most cases do not have the potential to release significant amounts of sulfate. Studies conducted in 1993, 1994 and 1996 used acid/base accounting (ABA) analytical techniques to predict the future geochemical behavior of the waste rock dumps. Confirmatory sampling was performed in 1999 to test the validity of the original predictions. Waste rock samples were analyzed for paste pH to determine if they had acidified after being placed on the dump, and paste conductivity to determine if significant concentrations of sulfate are being produced. Paste conductivity is a direct measure of the concentration of soluble salts in the sample. The 1999 sample results are summarized on Table 1. The potential to generate ARD or sulfate at each waste rock dump is discussed below.

2.1 Barneys Waste Rock Dumps

Waste rock excavated from the Barneys Canyon pit (Barneys pit) was placed immediately to the north and east of the pit (Figure 1). Less than five percent of the waste rock encountered in Barneys pit is estimated to have contained sulfides and almost all of the waste rock is composed of silty dolomite and calcareous sandstone. ABA analyses of the waste rock indicate that on average it is net-neutralizing and has no potential to generate ARD or sulfate when blended in the waste rock dump (SRK, 1993; Kennecott Barneys Canyon Mining Company, 1997).

The ten samples collected from the Barneys waste rock dumps in 1999 all had neutral to basic pH values (8.05 average) and low to moderate conductivity values (192 umhos/cm average). These results confirm that the dumps pose no risk to groundwater or surface water.

2.2 South Barneys Waste Rock Dumps

Waste rock excavated from the South Barneys Canyon South (SBCS) pit was placed immediately to the east, and waste rock from the North Barneys Canyon South (NBCS) pit was used to backfill the SBCS pit (Figure 1). The waste rock from both pits is composed of calcareous sandstone and quartzite.

Very little of the NBCS pit waste rock contained visible sulfides and ABA analyses of the waste rock indicate that it is strongly net-neutralizing. The waste rock has no potential to generate acid or sulfate when blended in the waste rock dump (SRK, 1993; Kennecott Barneys Canyon Mining Company, 1997). The four samples collected from the waste rock pit fill in 1999 all had neutral or basic pH values (7.24 average) and very low conductivity values (45 umhos/cm average).

Only about 0.1% of the waste rock excavated from the SBCS pit is estimated to contain visible sulfides, but much of the oxidized waste rock contains abundant sulfate minerals such as jarosite and barite. These minerals may release sulfate into water that contacts the waste rock dump.

ABA analyses indicate that on average the dump material is net-neutralizing and it does not represent a significant source of ARD potential (SRK, 1993; SRK, 1994; Kennecott Barneys Canyon Mining Company, 1997). Geochemical modeling indicates that the dump has some potential to release sulfate if sufficient moisture infiltrates into the waste rock (SRK, 1994). The modeling also predicts that even without revegetation it would require more than 100 years to establish a consistent flux of water through the waste, and in no case would any water discharge to the surface from the toe of the dump. These conclusions are supported by recent sampling and analysis. Four of the five waste rock samples collected in 1999 from the SBCS dump have neutral to basic pH values (7.68 average) and low conductivity values (74 umhos/cm average). The fifth sample was mildly acidic (pH 5.35) and had a moderately high conductivity value (356 umhos/cm) indicating that it could generate minor acidity and sulfate.

2.3 East Barneys Waste Rock Dump

Waste rock excavated from the East Barneys pit was placed in the south side of the Barneys pit (Figure 1). The East Barneys pit ore body was completely oxidized and no sulfide-bearing waste rock was encountered. In addition, most of the waste rock produced was composed of calcareous sandstone, so there is abundant neutralization capacity available in the waste rock pile. ABA analyses of the waste rock indicate that on average it is net-neutralizing and has no potential to generate ARD or sulfate drainage (Kennecott Barneys Canyon Mining Company, 1997).

The five samples collected from the East Barneys waste rock pit fill in 1999 all had neutral to basic pH values (7.76 average) and low conductivity values (118 umhos/cm average). As discussed in Section 3.1, the pit lake that is in contact with the dump material also has very low sulfate concentrations and a basic pH. These results confirm that the East Barneys pit waste rock poses no risk to groundwater or surface water.

2.4 Melco Waste Rock Dumps

Waste rock excavated from the Melco pit is being placed in Dry Fork Canyon immediately south of the pit and into Barneys Canyon immediately north of the pit (Figure 1). The waste rock is predominantly composed of calcareous sandstone, dolomite and quartzite. Dolomite and calcareous sandstone represent a smaller and smaller percentage of the waste rock production as mining progresses, so waste rock dumps created at the end of the mining operation will generally contain less neutralizing capacity than those created at the start.

During the early phase of mining at the Melco pit only three or four percent of the waste rock produced was sulfide-bearing. The waste dumps created during this period contain blended oxide and sulfide-bearing waste. ABA analyses indicate that on average the existing waste dumps are net-neutralizing and they do not represent a significant source of ARD potential (SRK, 1993; SRK, 1994; Kennecott Barneys Canyon Mining Company, 1997). However, geochemical modeling indicates that the dumps have some potential to release sulfate if sufficient moisture infiltrates into the waste rock (SRK, 1994). Over the entire life of the Melco pit, approximately seven percent of the total waste rock produced will be acid generating (Kennecott Barneys Canyon Mining Company, 1997). Most of this sulfide waste rock will be produced late in the pit's life. To insure that future waste rock dumps are also net neutralizing, sulfide-bearing waste rock is currently being segregated into special sulfide waste rock repositories. These repositories and sulfide waste segregation methods are discussed in Sections 2.5 and 4.0. Most of the existing South Melco dump was created when waste blending was practiced, and all of the North Melco dump was created after sulfide waste segregation was initiated.

The 15 samples collected in 1999 from the South Melco dump generally have a neutral pH (6.63 average) and low to moderate conductivity (449 umhos/cm average). However, the dump does contain pods of potentially acid and sulfate generating rock (Table 1). Two samples from the South Melco dump have pH values below 5.5 and conductivity values above 1200 umhos/cm. These results are consistent with the past practice of blending net neutralizing rock with a small amount of acid-generating rock that was described in the previous paragraph.

The 20 samples collected in 1999 from the North Melco dump generally have a neutral pH (7.35 average) and low to moderate conductivity (298 umhos/cm average). The Melco North dump also contains some small pods of acid or sulfate generating rock but they are much less common and contain fewer sulfides than in the South Melco dump. These results indicate that the waste rock segregation program that has been practiced since 1997 is working and that almost all sulfate and acid generating rock is currently being segregated into a sulfide repository.

2.5 Sulfide Rock Storage Areas

There are currently five areas where sulfide-bearing rock from the Melco pit is being stored or will be stored in the future. Sulfide waste rock from the Melco pit is currently placed in the Melco sulfide repository to the southeast of the pit (Figure 1). In the future sulfide-bearing waste rock from the pit will also be placed in the NBCS sulfide repository. Carbonaceous ore from the Melco pit is currently stored adjacent to the Melco sulfide repository. Sulfide ore from the Melco pit is currently stored on top of the Barneys 6300 Dump and on the ore stockpile above the crusher.

These materials all have similar ABA characteristics. They all contain abundant unoxidized pyrite and are either strongly acid generating and/or may generate large quantities of sulfate. The samples collected in 1999 from these areas generally have an acidic pH (3.09 average) and high conductivities (5290 umhos/cm average).

As described in Section 4.0, special management controls are applied to areas where sulfide rock is stored to minimize its potential impacts to surface and groundwater.

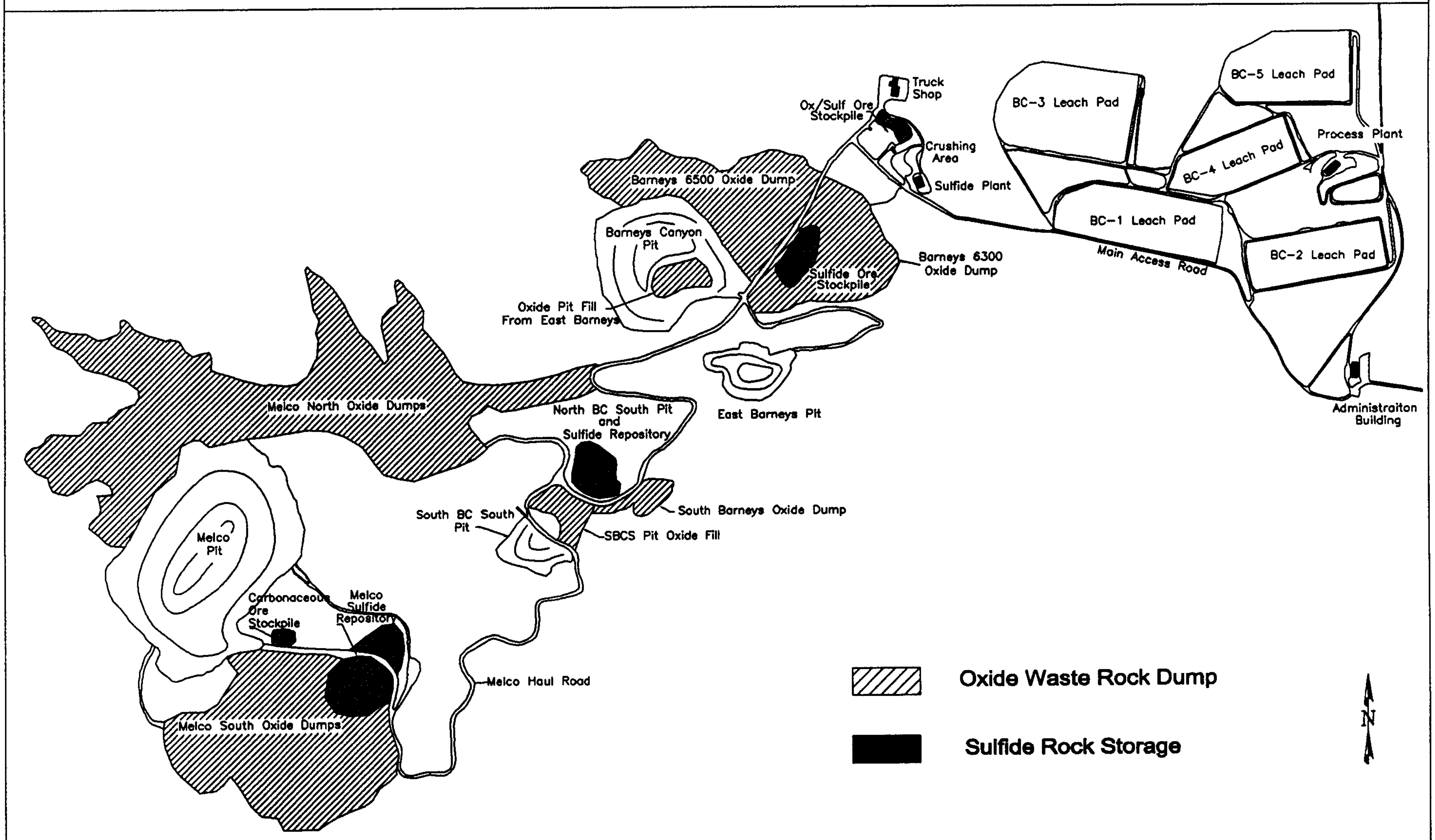
2.6 Dump Physical Characteristics and Sulfate Mobility

On average, all of the waste rock dumps are net-neutralizing and so have little potential to generate ARD. However, the SBCS and Melco dumps have been identified as a potential source of sulfate contamination by some earlier studies (SRK, 1994). These studies predict that relatively high concentrations of sulfate could develop in interstitial water in the dumps after five to ten years (with peak concentrations of up to 2700 mg/L). This sulfate does not pose an environmental hazard unless it can be mobilized out of the dump by water flowing through the waste rock. Several field conditions at the Barneys Canyon Mine minimize the potential for saturated flow conditions to be established and for sulfate to be mobilized out of the dumps:

1) All of the waste rock dumps except for some of the fill material in the Barneys pit are above the local water table. None of the waste rock dumps are in contact with any intermittent streams, springs or seeps except for a small spring at the base of the South Barneys dump. A survey of each drainage above the waste rock dumps was conducted during the peak spring runoff period in 1999. No flowing water was noted and no cut banks, channels or vegetation changes that would be indicative of past surface flow conditions could be identified.

2) The mine is in a semi-arid region that only receives about 17 inches of precipitation a year and has an annual evapotranspiration rate of about 35 inches per year. This limits the amount of precipitation that can infiltrate into the waste dumps. As discussed in Section 5.0, the placement of topsoil and the establishment of vegetation on the waste dump surfaces at closure will further reduce infiltration rates.

3) Much of the precipitation on the dumps is removed by surface runoff. The compaction provided by haul trucks and other equipment that operate on the active dumps reduces surface permeability and promotes runoff. Runoff is currently directed off of the dumps and into natural drainage channels around the mine.



KENNECOTT MINERALS
BARNEYS CANYON MINE

Figure 1 Site Map

sulfide site map.dwg 9-15-99

Waste Rock Disposal Area	Number of Samples	Average pH	pH Range	Average Conductivity(1)	Conductivity Range(1)
Barneys 6300 and 6500 Dumps	10	8.05	7.19 - 8.49	192	73 - 497
SBCS Pit Fill (from NBCS)	4	7.24	6.79 - 7.65	45	28 - 70
South Barneys Canyon South Dumps	5	7.22	5.35 - 7.91	131	29 - 356
Barneys Pit Fill (from East Barneys)	5	7.76	7.56 - 8.04	118	72 - 222
Melco North Dumps	20	7.35	6.08 - 8.40	298	49 - 1003
Melco South Dumps	15	6.63	3.67 - 8.27	449	71 - 1416
Sulfide Storage Areas	9	3.09	2.27 - 6.89	5290	1622 - 10,300
(1) Reported in umhos/cm					

Table 1 - Paste pH and Paste Conductivity Summary Table

3.0 PIT WALL ARD POTENTIAL

3.1 Barneys Canyon Pit

The Barneys pit walls are composed of silty dolomite of the Park City Formation and calcareous sandstone of the Kirkham Diamond Creek Formation. The pit walls are completely oxidized except for two isolated areas containing sulfide-bearing rock on the northeast and southwest walls. Overall, the pit walls are strongly net-neutralizing. Both of the sulfide areas are located near the bottom of the pit. One area has been partially flooded by the existing pit lake and the majority of the other will be covered by the ultimate pit lake. The water cover will limit oxygen availability and inhibit sulfide oxidation so these sulfide-bearing zones will not generate ARD. The waste rock from the East Barneys pit that was dumped into the south side of the Barneys Pit also covers one of the sulfide bearing zones. As discussed in Section 2.3 this rock is composed of highly oxidized calcareous sandstone and also does not pose a risk of ARD formation.

These conclusions are confirmed by the chemistry of the 50-ft deep lake that has formed in the pit since its closure in 1996. As shown on Table 2 the lake currently has a basic pH, low sulfate concentration and meets drinking water quality standards.

3.2 South Barneys Canyon Pits

The South Barneys pit walls are composed of calcareous sandstone of the Kirkham-Diamond Creek Formation and orthoquartzite of the Freeman Peak Formation. Both the SBCS and the NBCS ore bodies are strongly oxidized and there are few intact sulfides present, but both pits contain minor zones of sulfide-bearing rock.

The SBCS pit has been backfilled with generally net neutralizing waste rock from the NBCS pit (Section 2.2). The average ABA potential of the pit walls indicates that they are net-neutralizing (Kennecott Barneys Canyon Mine, 1997). The pit is above the water table and is not in contact with any intermittent streams. The waste rock fill will decrease the access of oxygen and water to the buried pit walls. The waste rock surface will also be revegetated during the waste rock reclamation program. This will increase water retention near the surface and will increase evapotranspiration, so very little water is anticipated to infiltrate into the filled pit. The risk of ARD formation in the NBCS pit is negligible.

The NBCS pit is currently empty but it will eventually become a sulfide waste rock repository for material removed from the Melco pit (Section 5.2). The average ABA potential of the pit walls indicates that they are strongly net-neutralizing (Kennecott Barneys Canyon Mine, 1997). The pit is above the water table and is not in contact with any intermittent streams. The repository will be designed to prevent significant infiltration of precipitation so the risk of ARD formation from the pit walls will be negligible.

3.3 East Barneys Canyon Pit

The East Barney pit walls are composed of calcareous sandstone of the Kirkham-Diamond Creek Formation. The orebody is totally oxidized and there are no intact sulfides remaining. The lack of sulfides and the neutralization potential provided by the sandstone indicate that there is no risk of ARD formation at the East Barneys pit. This conclusion is confirmed by the chemistry of the 20-ft deep lake that has formed in the bottom of the after pit after its closure in 1998. As shown on Table 2, the lake water currently has a basic pH and low sulfate concentrations.

3.4 Melco Pit

The Melco pit walls are composed of orthoquartzites of the Freeman Peak Formation and calcareous sandstone of the Kirkham-Diamond Creek Formation. The ore body is not as deeply weathered as the other pits and it is anticipated that about 20% of the ultimate pit walls will contain sulfide-bearing material. Most of the sulfide-bearing zones will be exposed in the lower half of the pit. These portions of the pit walls will be acid generating after closure. The ultimate floor of the Melco pit will be several hundred feet above the water table and the pit will not be in contact with any intermittent streams. The current pit walls also do not appear to intersect any perched water zones and no seeps or springs have been ever been observed. However, precipitation runoff from the pit walls may cause small amounts of ARD to flow to the floor of the pit where it will temporarily pool and infiltrate into the bedrock.

The current Mining and Reclamation Plan submitted to the State Division of Oil, Gas and Mining (March, 1997) requires that the floor and accessible benches of the Melco pit will be covered with six inches of topsoil and revegetated. Sulfide-bearing zones in the pit may require deeper soil coverage. This revegetation will decrease infiltration and runoff, and inhibit ARD formation. Other ARD control options are also being considered including:

1) Ensuring that the lowest point of the ultimate pit is in an oxidized area and designing the final pit so that water will flow to this point. This will insure that standing water in the bottom of the pit is in contact with benign rock and will minimize the time that water will be in contact with acid-generating rock.

2) Collecting highwall runoff from the upper, generally oxidized portions of the pit and diverting it out of the pit or directly to the bottom of the pit to avoid contact with the sulfide-bearing areas on the walls.

3) Placing limestone or strongly neutralizing waste rock in the bottom of the pit or on selected pit benches to neutralize runoff.

4) Constructing a passive aerobic or anaerobic treatment system in the bottom of the pit. Examples include anoxic limestone drains and artificial wetlands.

5) Applying a surface treatment to sulfide-bearing zones on the pit walls to inhibit sulfide oxidization. Many of these surface treatments such as use of potassium permanganate to coat sulfides with manganese oxide are still in the experimental stage but may be developed for large-scale use in the future.

LOCATION	SAMPLE DATE	PH	ALKALINITY (mg/L CaCO3)	TDS (mg/L)	SULFATE (mg/L)
Barneys Pit Lake	8/24/99	7.98	220	352	84
East Barneys Pit Lake	9/10/99	8.06	224	720	158

Table 2 - Recent Water Quality Data

4.0 SULFIDE ROCK MANAGEMENT

The waste rock dumps are generally net-neutralizing and contain relatively low sulfide concentrations. The largest risk of ARD and sulfate release is from the sulfide rock storage areas around the mine (Sections 2.0 and 3.0).

4.1 Sulfide Waste Rock

As discussed in Section 2.4 sulfide-bearing waste rock from the Melco pit is currently being diverted into designated sulfide waste rock repositories. The proper identification and handling of this rock is required to minimize the risk of ARD and sulfate release from the oxide dumps and in the sulfide repositories. To minimize potential contamination of surface and groundwater, the following management controls have been implemented:

1) Sulfide-bearing rock that contains economic concentrations of gold will be milled and processed for gold recovery. Processing removes most of the available pyrite and creates a generally inert material that is placed on the heap leach pads.

2) Waste rock from the Melco pit that contains more than 0.5 % sulfide sulfur will be segregated and placed into one of the designated sulfide repositories. This rock can be easily identified in the field based upon its grey to black color. In some instances, waste rock with sulfide sulfur concentrations as low as 0.3% may be diverted into the repositories if it is determined to be net acid generating and if it can be readily identified in the field.

3) During operation, the area on and around the sulfide waste rock repositories will be contoured so that surface water is diverted away from the sulfide-bearing waste and to insure that large pools of water do not form in contact with the waste. Water management systems around the stockpiles will be inspected on a regular basis.

4) Sulfide-bearing waste rock will be compacted as it is placed in the repository. This will generally be accomplished by placing the material in lifts of less than ten feet so that vehicle traffic compacts each lift.

5) As discussed in Section 5.2, the repositories will be capped and reclaimed at closure in a manner that limits the long-term access of oxygen and water.

4.2 Sulfide Ore

Although the sulfide ore stockpiles are temporary they do have the potential to generate ARD and sulfate while they are in existence. To minimize potential contamination of surface and groundwater the following management controls have been implemented:

1) Sulfide ore will only be stored on the 6300 foot level of the Barneys dump and on the stockpile immediately above the crusher.

2) The area on and around the stockpiles will be contoured so that surface water is diverted away from the sulfide ore and to insure that large pools of water do not form in contact with the ore. Water management systems around the stockpiles will be inspected on a regular basis.

3) The footprint of the ore stockpiles will be kept as small as possible and will be reduced as the volume of material in the stockpiles is reduced. This will minimize the amount of precipitation that comes into contact with the ore.

4) When a stockpile area is closed all residual sulfide-bearing rock will be removed. This material will either be processed or placed in one of the permanent sulfide waste rock repositories.

4.3 Carbonaceous Ore

All of the carbonaceous ore that is stockpiled south of the Melco pit will be removed by the end of mine life. This material will either be processed or will be placed into one of the permanent sulfide waste rock repositories.

5.0 FINAL WASTE ROCK DUMP DESIGN

Oxide waste rock dumps and sulfide repositories will be reclaimed at closure in order to minimize the infiltration of water and oxygen to the underlying waste rock.

5.1 Oxide Waste Rock Dumps

The pH and salinity of the oxide waste rock dumps is already in a range that is favorable for plant growth. The oxide dumps will be reclaimed in general accordance with the procedures outlined in the Mining and Reclamation Plan submitted to the Utah Division of Oil, Gas and Mining on March 7, 1997 (Kennecott Barneys Canyon Mining Company). Figure 2 is a schematic diagram showing the final dump design. The following reclamation procedures will be followed:

1) Dump surfaces will be regraded to promote sheet runoff with minimal erosion and to minimize ponding. Runoff will be directed back into natural drainages via sediment control structures or will be allowed to infiltrate into the subsurface at selected locations outside the dump footprint. All angle of repose slopes except for those in Dry Fork Canyon will be reduced to a maximum slope of 2.5:1 (22 degrees).

2) Runoff from areas adjacent to the oxide dumps will be either diverted around the dumps or will be held in ponds to encourage evaporation or infiltration into underlying natural alluvium or bedrock.

3) Any pockets of sulfide-bearing waste rock that are identified on the surface of the oxide dumps will be covered with a minimum of four feet of oxide waste rock during the regrading process described above.

4) A minimum of six inches of topsoil will be placed on top of all waste rock surfaces except the angle of repose slopes in Dry Fork Canyon.

5) All waste rock surfaces will be seeded in accordance with the Mining and Reclamation Plan.

The establishment of vegetation on the oxide dump surfaces will significantly increase evapotranspiration rates and will reduce both infiltration and runoff.

5.2 Sulfide Waste Rock Repositories

The Melco and the NBCS sulfide repositories are both several hundred feet above the local water table and are not near any intermittent streams or water bodies. Any potential surface runoff from areas adjacent to the repository will be captured and diverted around the site. When the repositories have been filled they will be contoured and capped in order to minimize infiltration of precipitation or snow melt through the surface of the material. Figure 2 is a schematic diagram showing the final design of the sulfide repository cover.

The top surface of both repositories will have a minimum slope angle of ten degrees. The compacted sulfide waste rock will be covered with a minimum of ten feet of inert or net-neutralizing oxide waste rock. A minimum of three feet of predominantly fine-grained soil from the Barneys pit area or equivalent will then be placed on top of the oxide cover. The thick soil and oxide waste rock cap above the sulfide material will allow deep-rooted plants to become established. To ensure the rapid establishment of deep-rooted plants, the caps will be revegetated according to the species list, seeding rates and seedling numbers listed in Table 3. This cover design is compatible with the semi-arid climatic conditions of the mine area and will provide a long-term barrier to water infiltration. The Barneys Canyon area receives about 17 inches of precipitation per year and the annual evapotranspiration rate is about 35 inches (Waste, Water and Land Inc., 1994). Under these conditions a store and release cover system is generally the most effective. Water is stored in the fine-grained soil and in the oxide waste rock in the wet season and is removed by evapotranspiration during the dry season. The presence of deep-rooting plants increases the effective thickness of the water storage zone. Covers of this design have been used successfully to cap waste rock at mining sites with similar climates (Bews et. al., 1997; Swanson et. al., 1995).

The cover design proposed above is significantly different from the cover design outlined in the 1994 Waste Rock Management Plan. The 1994 plan described a four or five foot-thick composite cover above the sulfide waste rock composed of from bottom to top: nine inches of clay or a flexible membrane liner; 12 inches of sand; 12 inches of well graded filter material; and two feet of a mixture of oxide waste rock and topsoil. The old cover design is considered less effective than the present design for a number of reasons:

1) It is reliant on an impermeable liner that can be damaged in the long-term by rooting plants, burrowing animals and subsidence of the underlying fill material (Bowerman and Redente, 1998).

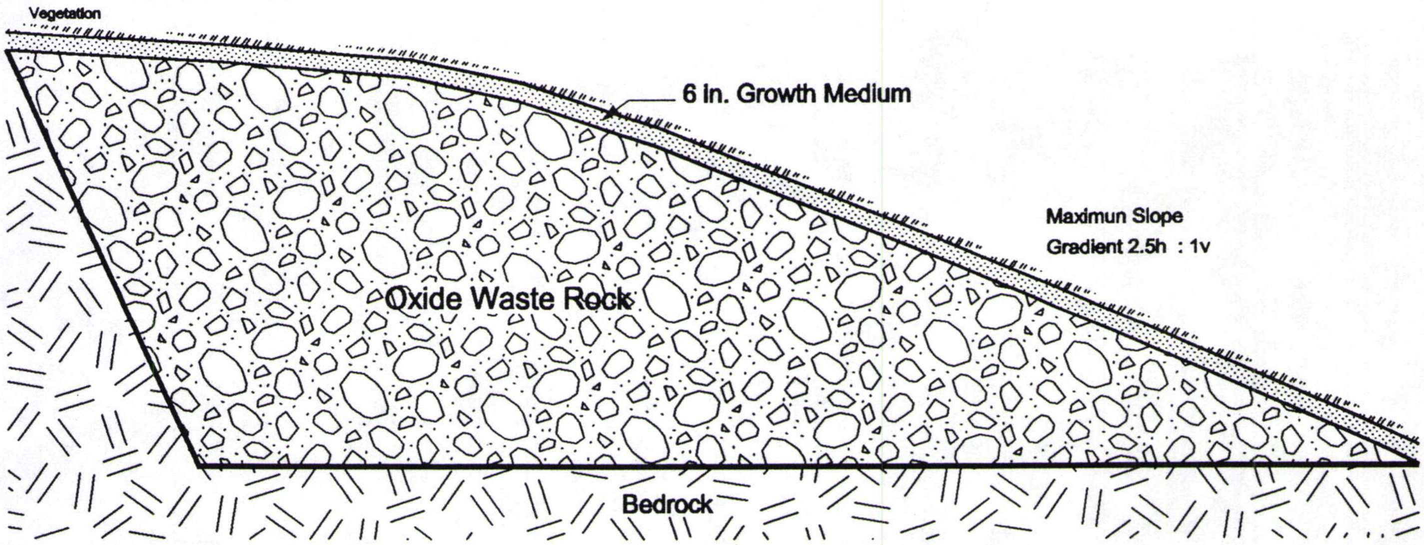
2) In semi-arid climates clay liners are susceptible to drying and cracking which severely limits their effectiveness as a hydraulic barrier (Daniel and Wu, 1993).

3) It provides much less capacity to store water during the wet season for release during the dry season, and so is more likely to allow water to contact the underlying sulfide waste rock should the low permeability barrier fail.

4) It provides a much shallower rooting zone for plants growing on top of the cover and so reduces evapotranspiration.

As described by Swanson, Barbour and Wilson (1997) the use of low permeability barriers is commonly effective in wet climates, but in semi-arid climates it can lead to very high infiltration rates.

Cover for Oxide Overburden Piles



Cover for Sulfide Overburden Repositories

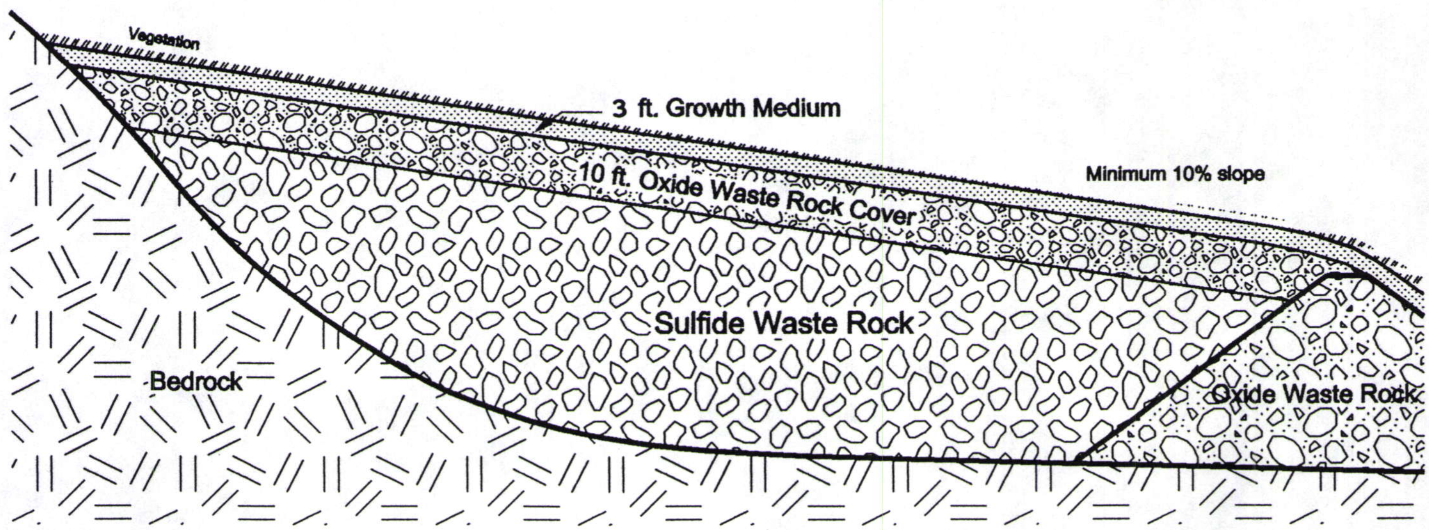


Fig. 2 Schematic Diagrams for Overburden Covers

overburden.dwg

Common Name	Scientific Name	Pure Live Seed (lbs/acre)
Grasses		
bluebunch wheatgrass(1)	Agropyron spicatum	2
intermediate wheatgrass	Agropyron intermedium	2
great basin wildrye	Elymus cinereus	2
canby bluegrass	Poa canby	1
mountain rye	secale montanum	3
Legumes		
yellow sweetclover	Melilotus officinalis	0.5
cicer milkvetch	Astragalus cicer	2
ladak alfalfa	Medicago sativa	1
Forbs		
white yarrow	Achillea millefolium	0.1
small burnett	Sanguisorba minor	1.5
palmer penstemon	Penstemon palmeri	0.5
Shrubs		
mountain big sagebrush	Artemisia tridentata vaseyana	0.2
rubber rabbitbrush	Chrysothamnus nauseosus	0.5
forage kochia	Kochia prostrata	0.5
woods rose	Rosa woodsii	1
Total		**17.8**
Seedlings		
gambel oak	Quercus gambelli	150 plants/acre
common snowberry(2)	Symphoricarpus albus	150 plants/acre
bitterbrush	Purshia tridentata	150 plants/acre
curl leaf mountain mahagany	Cercocarpus ledifolius	150 plants/acre
(1) Western wheatgrass (Agropyron smithii) may be substituted for bluebunch wheatgrass		
if necessary.		
(2) Mountain Snowberry (Oreophilus symphoricarpus) may be substituted for common		
snowberry if necessary.		

Table 3 - Seed and Seedling Mixture for the Barneys Canyon Sulfide Repository Caps

6.0 REFERENCES

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